Appendix A: Articles Reviewed Since ECRI Report

Author	Journal or Book	Year	Type of Study	Outcomes Studied	Patient Characteristics	Results
Baker LL, Chambers R, et al	*Diabetes Care*	1997	Single Blinded, Randomized Controlled Trial	Weekly healing rate based on change in wound perimeter	80 patients (55 men, 25 women) Age range 30-82 years 114 wounds Diabetic with open ulcers Four groups of patients received standard wound care therapy plus the following form of electrical stimulation A: asymmetric biphasic B: symmetric biphasic MC: minimal current Control: sham	Healing rate in Group A but not Group B increased compared to control group. Wound healing rate as a percentage change in wound area by protocol for a subgroup of which required > 8 days to heal: A: 27.0 +/- 4.0 B: 16.4 +/- 6.1 MC: 17.2 +/- 4.8 Control: 17.3 +/- 2.3 Differences in healing rates (overall and for subgroups) were not statistically significant. Used one-way analysis of variance.
Baker LL, Rubayi S, et al	*Wound Rep Reg*	1996	Single Blinded, Randomized Controlled Trial	Weekly healing rate and complete healing of ulcer Wound healing rate as a percentage change in wound size per week.	80 patients Age Range: 17-76 years Mean age: 35 years 192 wounds Spinal cord injury and pressure ulcers Four protocols: A: asymmetric biphasic current B: symmetric biphasic current MC: microcurrent Control: no current	Healing rates: Protocol A: 36.4 +/- 6.2 B: 29.7 +/- 5.1 MC: 23.3 +/- 4.8 Control: 32.7 +/- 7.0 Data subdivided into good vs poor response. Only difference was between A protocol and the MC and Control protocols. Results not statistically significant.

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Cosmo P, Svensson H, et al	*Scand J Plast Reconstr Hand Surg*	2000	Case series	Changes in blood flow by laser doppler imaging	15 patients Mean age 73 years (38-85 years) Chronic leg ulcers of various causes 12 venous ulcers 2 arterial ulcers 1 vasculitis Duration of ulcer 3 months to 16 years Low frequency TENS applied for 60 minutes Blood flow measured every 5 minutes	After 60 minutes, mean blood flow had increased in the ulcer by 35%, and in the intact skin surrounding the ulcer by 15%. 15 minutes after treatment, mean blood flow increase of 29% in the ulcer, and 9% in the skin. Data statistically significant at highest tolerable intensity.
Flesischli JG, Laughlin TJ	*Journal of Foot Ankle Surgery*	1997	Literature Review	Review of literature on electrical stimulation (Conducted after ECRI report)	NA	"Most clinical studies in this area, however, are descriptive case series with ill-defined patient populations. There are also wide variation in the dose, frequency, and method of delivery of the electrical stimulation. A thorough review of the literature reveals anecdotal evidence for the use of electrical stimulation in wound healing, but strong scientific evidence has not been demonstrated. The current review also demonstrates the need for further study in this area."

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Franz RA.	*Clinics in Geriatric Medicine*	1997	Review Article	Reviews the literature on adjuvant therapies for ulcer care	NA	Notes that "Preliminary reports provide encouraging support for electrical stimulation's potential to enhance the wound healing process."
Franz, RA	*unpublished*		Double-blinded randomized controlled trial	Number of days for the ulcer to reduce in volume or surface area by 50% from baseline	50 patients originally met inclusion criteria. 37 patients with Stage II-IV pressure ulcers of at least 3 months duration. Mean age = 74.4 years Study conducted from 5/89 to 8/92. Subjects had to have a stage 2 ulcer or greater over a bony prominence that had been caused by prolonged pressure; ulcer must have been resistant to healing for at least 3 months with conventional treatment. Treatment with TENS was applied for 30 minutes, 3 times a day for 8 weeks.	No statistically significant difference between experimental and control group at the end of the study for the following: Complete healing Median time to 50% reduction in wound surface area Median time for volume of ulcers in experimental group to decrease by 50% "statistically significant" (p not specified) faster than control. No intent-to-treat analysis.

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Gardner SE, Frantz RA, Schmidt FL.	*Wound Rep Reg*	1999	Meta-analysis	Healing rates	28 studies were reviewed for inclusion; 15 studies (24 electrical stimulation samples, 15 control samples) met inclusion criteria. Inclusion criteria: Examine ulcer or periulcer estim Include human subjects Include chronic wounds (pressure, venous, arterial, or neuropathic) Report quantitative data of baseline and post-treatment wound size, or report percent healing per week. 8 were blinded, placebo-controlled RCTs 1 non-placebo controlled RCT 5 nonrandomized trials 1 descriptive design	Rate of healing per week was 22% for electrical stimulation samples, and 9% for control samples. By type of estim: CDC 21.69 PDC 24.60 For pressure ulcer, mean healing per week was 16.63 vs 3.30 without estim. Data was not significant for: 1. Chronic wounds w/TENS 19.97 w/o ES 9.10 2. Venous ulcers w/ ES 7.01 w/o ES 7.39 3. Mixed chronic and other ulcers w/ ES 28.26 w/o ES 20.73

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Gilcreast DM, Stotts, NA, Froelicher ES, et al	*Wound Rep Reg*	1998	Clinical trial	Transcutaneous oxygen levels before, during, and after application of ES to the foot	132 diabetic patients with, or at risk for foot ulcers Years with diabetes: 15 Average age: 66 years Presence of foot ulcer: 33 in 24 subjects Sample size was calculated using an effect size of 9% difference in skin perfusion. Subjects recruited from three large diabetic foot clinics on the West Coast.	Grouped foot transcutaneous oxygen levels decreased following electrical stimulation ($F=5.66$; $p=0.0039$) Analysis of variance showed that initial transcutaneous oxygen was significantly higher than subsequent readings. 35 subjects showed increased transcutaneous oxygen, and 97 experienced a decreased transcutaneous oxygen reading.
Jacques PF, Brogan MS, and Kalinowski D.	*Physician Assistant*	1997	Case Report	Healing of ulcer	An 81 year old diabetic with three foot ulcers of unspecified duration and unspecified etiology (author classifies the ulcers as stage IV using the classification system for pressure ulcers without stating the type of ulcer, while the reported history and physical suggests a possible arterial etiology)	Author reports complete healing of the ulcers following a course of high voltage monophasic pulsed electrical stimulation
Kloth LC, and McCulloch JM.	*Adv Wound Care*	1996	Review Article	Reviews literature on wound healing	NA	

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Ovington LG.	*Ostomy/Wound Management*	1999	Opinion piece	NA	NA	Suggests changing the strength of evidence for AHCPR's recommendation on electrical stimulation for recalcitrant pressure ulcers from level B to level A. Based this on an additional randomized controlled trial, not reviewed by AHCPR.
Peters EJ, Armstrong DG, et al	*Journal of Foot and Ankle Surgery*	1998	Prospective clinical trial	Transcutaneous oxygen measurements Laser Doppler flowmetry	19 subjects with diabetes mellitus 11 subjects had impaired peripheral perfusion Average age: 55.7 years (37-69 years) Subjects studied over 2 days. Day #1 One foot was electrically stimulated for four 60 minute periods Vascular perfusion assessed pre/post stimulation Day #2 no electrical stimulation applied; noninvasive vascular measurements repeated.	For those with impaired peripheral perfusion, a significant rise in tissue oxygenation as compared to the control was measured during the first 5 minutes ($p<0.04$) For those without vascular disease, there was no significant increase compared to baseline ($p=0.28$) Stimulated feet did not show any higher perfusion levels than the control feet. Laser Doppler flowmetry was similar in the experimental and control groups.
Sheffet A, Cytryn A, Louria D.	*Ostomy Wound Management*	2000	Literature review			

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Sumano H, and Mateos G.	*American Journal of Acupuncture*	1999	Case Series	Outcome was described as poor, fair, or excellent Poor: less than 50% recovery Fair: 60-90% recovery Excellent: Greater than 90% recovery Determined by the authors	44 patients (29 females, 15 males) No patients older than 60 years. 34 skin lesions 10 second-degree burns All patients had previously tried conventional therapy, with unsatisfactory results. Patients were treated with estim using a WQ-6F acupuncture stimulator with an absolute charge density of 0.4-0.8 coulombs/cm squared. Treatment applied for 20 minutes either daily or every other day.	41 patients experienced an excellent outcome 3 patients fair outcome

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Unger PG	*unpublished*		Randomized Double-blinded, Prospective	Complete healing of ulcer (change in size of each wound, with reduction in size being main criteria)	17 patients (7 males, 10 females) with pressure ulcers randomly assigned to either HVPC or placebo 9 experimental 8 control group Mean age 81 years Patients were treated twice a day for 30 minutes until the wound was healed. Standard care received as part of the treatment. Conducted at 5 long term care facilities.	8 of 9 experimental patients, and 3 of the 8 control patients experienced complete healing of wounds (p=0.043) Among patients whose wounds completely healed, time required for healing was not statistically significant. Data was not statistically significant for average time to healing.
Unger PG	*unpublished*		Clinical trial	Complete healing of wound Time of healing	154 patients Majority of patients over 65 years of age 223 wounds: venous 42 arterial 43 diabetic 6 pressure 126 surgical 6 Multi-study clinical trial, performed in 10 skilled nursing facilities and 1 acute care hospital	200 wounds healed (89.7%) 23 non-healed Mean healing time: 10.85 weeks

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Zuder D, Steins A	*abstract*		Clinical trial	Microcirculatory changes as measured by capillary density, oxygen pressure, and vascular reserve.	16 patients (12 female, 4 male) with venous leg ulcers Average age 70.6 years Average duration of ulcers 70.8 months Average duration of therapy 39 days	Compared to measurements at the beginning of the study, measurements at the conclusion of the study showed increased capillary density and oxygen pressure in the ulcers. Ulcer surface area decreased an average of 69% over the course of the study, and 2 ulcers healed completely.